

Claim(s)

1. A manufacturing method for a winding assembly of a rotating electrical machine, comprising a winding step of winding respective winding members so that each of the plural winding members has a first straight part, a second straight part, a first turn part connecting the first straight part and the second straight part at their one sides, and a second turn part connecting the first straight part and the second straight part at the other sides,

wherein at the winding step, a rotation block and a fixed block are used, the rotation block includes a rotation surface rotatable around a rotation axis, the fixed block includes a first and a second surfaces opposite to each other and a shaping surface formed between end parts of the first surface and the second surface, and the shaping surface is made to have a substantial semicircular shape with the rotation axis as a center and is extended in a direction of the rotation axis, and

the winding step includes a first and a second wire rod feed steps, and a first and a second wire rod turn steps, at the first and the second wire rod feed steps, plural wire rods are supplied such that in a state where they are arranged substantially in parallel to each other, the wire rods extend from the first surface of the fixed block onto the rotation

surface of the rotation block and project by a predetermined dimension from the rotation axis, and consequently, lengths of the first and the second straight parts are respectively set, and at the first and the second wire rod turn steps, the plural wire rods on the rotation surface of the rotation block, together with the rotation block, are rotated, so that the plural wire rods are simultaneously bent along the shaping surface, and the first and the second turn parts are respectively formed.

2. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 1, wherein the first wire rod feed step, the first wire rod turn step, the second wire rod feed step, and the second wire rod turn step are carried out in this order in the winding step, length of the first straight part is set for the plural wire rods by the first wire rod feed step, the first turn part is formed for the plural wire rods by the first wire rod turn step, length of the second straight part is set for the plural wire rods by the second wire rod feed step, and the second turn part is formed for the plural wire rods by the second wire rod turn step.

3. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 1, wherein a wire rod feed mechanism is further used, and at the first and the second wire rod feed steps, the wire rod feed

mechanism simultaneously supplies the plural wire rods in a state where they are arranged substantially in parallel to each other, and the wire rod feed mechanism nips and holds the plural wire rods at the first and the second wire rod turn steps.

4. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 1, wherein at the first and the second wire rod turn steps, the rotation block simultaneously bends the plural wire rods along the shaping surface by a first rotation movement of rotation in a predetermined direction around the rotation axis from its original position.

5. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 4, wherein the rotation surface of the rotation block presses the plural wire rods to the second surface of the fixed block at an end of the first rotation movement, and the plural wire rods are bent by substantially 180 degrees with respect to the rotation axis.

6. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 4, wherein after the first rotation movement, the rotation block performs a second rotation movement in a direction opposite to the first rotation movement, and is returned to the original position.

7. The manufacturing method for the winding assembly

of the rotating electrical machine according to claim 1, wherein an auxiliary block is further used, the auxiliary block faces the first surface of the fixed block at at least the first and the second turn steps and prevents the plural wire rods from outgoing from the first surface of the fixed block in accordance with rotation of the rotation block.

8. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 7, wherein the auxiliary block faces the first surface of the fixed block also at the first and the second wire rod feed steps, and the plural wire rods are supplied from between the first surface of the fixed block and the auxiliary block to the rotation surface of the rotation block.

9. A manufacturing method for a winding assembly of a rotating electrical machine, comprising a winding step of winding respective winding members so that each of the plural winding members has a first straight part, a second straight part, a first turn part connecting the first straight part and the second straight part at their one sides, and a second turn part connecting the first straight part and the second turn part at the other sides,

wherein at the winding step, a rotation block and a fixed block are used, the rotation block includes a rotation surface rotatable around a rotation axis, the fixed block includes a first and a second surfaces opposite to each other and a shaping

surface formed between end parts of the first surface and the second surface, and the shaping surface is made to have a substantial semicircular shape with the rotation axis as a center and is extended in a direction of the rotation axis, and

the winding step includes a first and a second wire rod feed steps, and a first and a second wire rod turn steps, at the first and the second wire rod feed steps, plural wire rods are supplied such that in a state where they are arranged substantially in parallel to each other, they extend along a supply line inclined by a predetermined angle  $\alpha$  with respect to the rotation axis from the first surface of the fixed block onto the rotation surface of the rotation block and project by a predetermined dimension from the rotation axis, and consequently, lengths of the first and the second straight parts are respectively set, and at the first and the second wire rod turn steps, the plural wire rods on the rotation surface of the rotation block, together with the rotation block, are rotated, so that the plural wire rods are simultaneously bent along the shaping surface, and the first and the second turn parts are respectively formed.

10. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 9, wherein the predetermined angle  $\alpha$  is substantially 60 degrees.

11. The manufacturing method for the winding assembly

of the rotating electrical machine according to claim 9, wherein the rotation block is disposed at one side of a rotator, and as a result that the plural wire rods are simultaneously bent at the first and the second wire rod turn steps, the plural wire rods go away from the rotator.

12. A manufacturing method for a winding assembly of a rotating electrical machine, comprising a winding step of winding respective winding members so that each of the plural winding members has a first straight part, a second straight part, a first turn part connecting the first straight part and the second straight part at their one sides, and plural second turn parts connecting the first straight part and the second turn part at the other sides,

wherein at the winding step, a rotation block, a fixed block and a wire rod feed mechanism are used, the rotation block includes a rotation surface rotatable around a rotation axis between an original position and a rotation position, the fixed block includes a first and a second surfaces opposite to each other and a shaping surface formed between end parts of the first surface and the second surface, the shaping surface is made to have a substantial semicircular shape with the rotation axis as a center and is extended in a direction of the rotation axis, and the wire rod feed mechanism is constructed to supply the plural wire rods in a state where they are arranged substantially in parallel to each other and along a supply line

inclined by a predetermined angle  $\alpha$  with respect to the rotation axis,

at the winding step, a first wire rod feed step, a first wire rod turn step, a second wire rod feed step, and a second wire rod turn step are performed in this order, at the first and the second wire rod feed steps, the rotation surface of the rotation block is at the original position, the wire rod feed mechanism supplies the plural wire rods so that they extend from the first surface of the fixed block onto the rotation surface of the rotation block and project from the rotation axis by a predetermined dimension, and consequently, lengths of the first and the second straight parts are set, and at the first and the second wire rod turn steps, the plural wire rods are simultaneously bent along the shaping surface by a first rotation movement in which the rotation surface of the rotation block rotates around the rotation axis from the original position to the rotation position in a predetermined direction, and the first and the second turn parts are respectively formed, and after the first and the second turn parts are formed, the rotation surface of the rotation block is returned to the original position in accordance with a second rotation movement in which the rotation block is rotated reversely to the first rotation movement,

the winding step includes a lead wire preparation step between the first wire rod feed step and the next first wire

rod turn step, this lead wire preparation step includes a cut step of cutting at least one wire rod selected from the plural wire rods between the fixed block and the wire rod feed mechanism, and a cut end part of the cut wire rod is bent at the next first wire rod turn step by the rotation of the rotation block in a state where it projects more than the other wire rods.

13. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 12, wherein an auxiliary block is further used, the auxiliary block is retracted to a side of the wire rod feed mechanism at an initial stage of the first wire rod turn step so as not to hinder that the cut end part of the cut wire rod is rotated in accordance with the rotation of the rotation block, and after the cut end part of the cut wire rod is rotated by a predetermined angle, the auxiliary block is returned to a position where it faces the first surface of the fixed block, and hinders that as the other wire rods are bent, the other wire rods are outgone from the first surface of the fixed block.

14. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 12, wherein when the rotation surface of the rotation block is returned from the rotation position to the original position, a first upward movement to raise the rotation block from the second surface of the fixed block, a backward movement to move



the rotation block backward in a direction of the rotation axis subsequently to the first upward movement, the second rotation movement subsequent to the backward movement, a downward movement to cause the rotation block to become lower than a position of the first surface of the fixed block subsequently to the second rotation movement, a forward movement to move the rotation block forward in the direction of the rotation axis subsequently to the downward movement, and a second upward movement to align the rotation surface of the rotation block with the first surface of the fixed block subsequently to the forward movement are given.

15. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 12, wherein at the first wire rod feed step in the winding step, a first wire rod group of adjacent rods of half of the plural wire rods arranged in a direction in which they are substantially parallel to each other is fed to project from a remaining second wire rod group, and at the next wire rod turn step, except for the second wire rod group, the first wire rod group is bent by the first rotation movement of the rotation block.

16. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 15, wherein a first auxiliary block facing the first surface of the fixed block at the original position and a second auxiliary

block always facing the first surface of the fixed block are further used, the first and the second auxiliary blocks are separated in a direction in which the plural wire rods are arranged substantially in parallel to each other, the first wire rod group is supplied to between the first auxiliary block and the first surface of the fixed block, the second wire rod group is supplied to between the second auxiliary block and the first surface of the fixed block, the first auxiliary block is retracted in a direction of the wire rod feed mechanism at an initial stage of the final wire rod turn step, and the first auxiliary block is returned to the original position after an end part of the first wire rod group is rotated to a predetermined angle.

17. The manufacturing method for the winding assembly of the rotating electrical machine according to any one of claims 1, 9 and 12, wherein a deformation step of deforming, among the plural winding members, a first and a second winding members in which the first straight part and the second straight part cross each other at their midpoints is carried out after the winding step, at the deformation step, first end parts of the first straight parts of the first and the second winding members and first end parts of the second straight parts of those are deformed in directions opposite to each other, second end parts of the second straight parts of the first and the second winding member and second end parts of the first straight

parts of those are deformed in directions opposite to each other, a first parallel straight part is formed at each of the first straight parts of the first and the second winding members, and a second parallel straight part is formed at each of the second straight parts of those.

18. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 17, wherein at the deformation step, a winding combination in which the first and the second winding members are combined is formed, and in the winding combination, the second parallel straight part of the second winding member is overlapped on the first parallel straight part of the first winding member, and the first parallel straight part of the second winding member is overlapped under the second parallel straight part of the first winding member.

19. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 18, wherein an insertion step of inserting the winding combination into slots of an iron core is further carried out after the deformation step, and at this insertion step, the winding combination is combined and inserted such that among the plural slots formed at a predetermined pitch on the iron core, at a predetermined slot, the first parallel straight part of the first winding member is positioned at a first layer, and the second parallel straight part of the second winding member is

positioned at a second layer, and at a slot spaced from the predetermined slot by a predetermined number of slots, the first parallel straight part of the second winding is positioned at the first layer, and the second parallel straight part of the first winding member is positioned at the second layer.

20. The manufacturing method for the winding assembly of the rotating electrical machine according to claim 17, wherein a press step of pressing the first and the second winding members so that a first plane on which each of the first straight parts is positioned and a second plane on which each of the second straight parts is position approach each other.

21. A manufacturing apparatus for a winding assembly of a rotating electrical machine used in a winding step of winding respective winding members so that each of the plural winding members has plural first straight parts, plural second straight parts, first turn parts connecting the first straight parts and the second straight parts at their one sides, and second turn parts connecting the first straight parts and the second straight parts at the other sides,

wherein the manufacturing apparatus comprises a rotation block, a fixed block and a wire rod feed mechanism, the rotation block includes a rotation surface rotatable around a rotation axis, the fixed block includes a first and a second surfaces opposite to each other and a shaping surface formed between

end parts of the first surface and the second surface, the shaping surface is made to have a substantial semicircular shape with the rotation axis as a center and is extended in a direction of the rotation axis, and the wire rod feed mechanism is constructed to supply plural wire rods in a state where they are arranged substantially in parallel to each other,

the winding step includes a first and a second wire rod feed steps, and a first and a second wire rod turn steps, at the first and the second wire rod feed steps, the wire rod feed mechanism supplies the plural wire rods such that in a state where they are arranged substantially in parallel to each other, the wire rods extend from the first surface of the fixed block onto the rotation surface of the rotation block and project by a predetermined dimension from the rotation axis, and consequently, lengths of the first and the second straight parts of each of the plural wire rods are set, and at the first and the second wire rod turn steps, the plural wire rods on the rotation surface of the rotation block, together with the rotation block, are rotated, so that the plural wire rods are simultaneously bent along the shaping surface, and the first and the second turn parts are respectively formed.

22. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 21, wherein the wire rod feed mechanism supplies the plural

wire rods along a supply line inclined by a predetermined angle  $\alpha$  with respect to the rotation axis.

23. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 22, wherein the predetermined angle  $\alpha$  is set to substantially 60 degrees.

24. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 21, wherein the first wire rod feed step, the first wire rod turn step, the second wire rod feed step, and the second wire rod turn step are carried out in this order, and in accordance with this, the wire rod feed mechanism intermittently supplies the plural wire rods at each of the first and the second wire rod feed steps, and the rotation block intermittently performs a rotation movement at each of the first and the second wire rod turn steps.

25. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 21, wherein the rotation block performs a first rotation movement in a predetermined direction at an initial period in the first and the second wire rod turn steps, and performs a second rotation movement in a reverse direction at a latter period, and after the plural wire rods are bent along the shaping surface by the first rotation movement, it is returned to an original position in accordance with the second rotation

movement.

26. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 25, wherein at the latter period, the rotation block performs a first upward movement to rise from the second surface of the fixed block, a backward movement to move backward along the rotation axis subsequently to the first upward movement, the second rotation movement subsequent to the backward movement, a downward movement to move downward in a direction opposite to the first upward movement subsequently to the second rotation movement, a forward movement to move forward along the rotation axis subsequently to the downward movement, and a second upward movement to align with the first surface of the fixed block subsequently to the forward movement.

27. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 21, wherein the manufacturing apparatus further comprises an auxiliary block, the auxiliary block faces the first surface of the fixed block at at least each of the wire rod turn steps, and prevents the plural wire rods from outgoing from the first surface of the fixed block in accordance with rotation of the rotation block.

28. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 27, wherein the auxiliary block is constructed to be capable

of retracting from a position where it faces the first surface of the fixed block to a retract position at a side of the wire rod feed mechanism.

29. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 21, wherein the manufacturing apparatus further comprises a first and a second auxiliary blocks facing the first surface of the fixed block at the wire rod turn step, the first auxiliary block prevents, among the plural wire rods, half of the wire rods adjacent to each other in the direction of the rotation axis from outgoing from the first surface of the fixed block, and the second auxiliary block prevents the remaining wire rods from outgoing from the first surface of the fixed block in accordance with rotation of the rotation block.

30. The manufacturing apparatus for the winding assembly of the rotating electrical machine according to claim 29, wherein the first auxiliary block is constructed to be capable of retracting from the first surface of the fixed block to the retract position at the side of the wire rod feed mechanism.